This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.
+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.
+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.
+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at http://books.google.com/

COUNTWAY LIBRARY
HC 2836 F

THE HUNTERIAN ORATION.

ROYAL COLLEGE OF SURGEONS OF ENGLAND.

FEBRUARY 14th, 1895.

BY

J. W. HULKE, F.R.S.

T
1806

Digitized by Google

BOSTON MEDICAL
JAN 29 1964
LIBRARY
t. 1806

Digitized by Google

Digitized by Google

Pei 30

Digitized by Google

HUNTERIAN ORATION.

Digitized by Google

Digitized by Google

THE

HUNTERIAN ORATION:

ROYAL COLLEGE OF SURGEONS OF ENGLAND.

FEBRUARY 14TH, 1895.

BY

J. W. HULKE, F.R.S.,

PRESIDENT OF THE ROYAL COLLEGE OF SURGEONS OF ENGLAND.

LONDON:

TAYLOR & FRANCIS, RED LION COURT, FLEET STREET.

1895.

Digitized by Google

ALERE FLAMMAM.

PRINTED BY TAYLOR AND FRANCIS,
RED LION COURT, FLEET STREET.

Digitized by Google

DEDICATION.

THIS ORATION, DELIVERED IN THE THEATRE OF THE ROYAL COLLEGE OF SURGEONS OF ENGLAND ON FEBRUARY 14TH, 1895, THE 167TH ANNIVERSARY OF

JOHN HUNTER'S BIRTH,

BY J. W. HULKE, PRESIDENT, IS BY HIM DEDICATED TO HIS COLLEAGUES IN THE COUNCIL, AT WHOSE INSTANCE IT IS PUBLISHED.

NOTE.

The above dedication was prepared by the Author of this Oration in anticipation of the Council's usual request; but his death from inflammation of the lungs on February 19th — five days after the celebration of the Hunterian Anniversary—deprived the Council of the opportunity of expressing its wishes. Under these sad and exceptional circumstances, the Council has undertaken the publication of its late President's Oration as a tribute to the memory of one for whom all its Members had a high regard, and has delegated the duty of seeing the work through the press to Mr. Thomas Bryant, a past President of the College, who, at a few hours' notice, kindly read the Address on February 14th.

Digitized by Google

Digitized by Google

THE

HUNTERIAN ORATION.

MR. VICE-PRESIDENT, VISITORS, FELLOWS AND MEMBERS OF THE ROYAL COLLEGE OF SURGEONS OF ENGLAND,

We meet to-day to commemorate the 167th anniversary of the birth of John Hunter, that remarkable man whose name in this College is as a living presence, who did so much and with such great success, last century, to raise Surgery from the lower grade of an empirical handicraft, which it then too greatly resembled, to the dignity of a branch of science by basing the principles that should guide its practice on the combined foundation of Anatomy, Physiology, and Pathology.

His great achievements as a Surgeon, his life-history, and his personality have been so frequently dwelt on here that I may pass these by and at once take up the theme on which I would speak to-day:—its subject is, John Hunter, the *Biologist*, the sagacious

Digitized by Google

investigator and interpreter of "Organic Nature." Of John Hunter in this character I can, however, offer you only a very incomplete sketch, since even if the time at my disposal permitted, and had I the necessary ability for such a task (a gift I may not claim), the materials for a complete presentment of him as a Biologist do not now exist; for ten large bound volumes of manuscript, written mostly by his assistants at his dictation, and then revised, added to and corrected by himself, embodying the records of the labours of many years, purchased together with his museum by the nation, which made our College their custodian, were about 30 years after John Hunter's death designedly burned by Sir Everard Home, his brother-in-law and executor. When interrogated by the Board of Curators respecting this act, he alleged that he had destroyed these MSS. by John Hunter's expressed desire, as being by him considered too imperfect for the public eye.

That these ten volumes of MSS. were included under the words "collections and everything belonging thereto," which John Hunter in his last will directed should be offered to the Government "in one lot," is not open to doubt; yet Sir Everard Home, shortly before the transfer of the "Collections" from Leicester Square to Lincoln's Inn Fields, and therefore after their purchase, had them removed to his own house. The Board of Curators of the Museum of the College appear not to have known that the MSS. had existed until after their destruction.

Digitized by Google

This irreparable loss looms the larger when we study John Hunter's Anatomical and Physiological Collections; when we ponder on the fragments of his writings rescued from destruction by the solicitude of William Clift, his devoted assistant, our first Conservator; and when we read his lectures and other papers collected and published by this College, and by Palmer and Owen.

The better my knowledge of the extensive series of anatomical and physiological preparations (nearly all made by John Hunter's own hands, a series which may properly be regarded as the centre around which are clustered our own now very greatly extended and in some respects unsurpassed collections), the more profoundly am I impressed with the vastness of our great master's anatomical and physiological work, which, it should be remembered, was all accomplished within the relatively short space of 30 years, broken in upon by frequent and severe illness, and by the many interruptions incidental to the life of a busy practising surgeon. I repeat, the better my acquaintance with the Hunterian series, the more am I impressed with John Hunter's sagacity, for in this series of preparations we have not the bald presentments of disconnected facts, but each preparation unfolds a tale, each conveys a lesson, each is a link in a chain, and not infrequently one clears up something which is but obscurely represented or only hinted by another.

The overshadowing greatness of his Zootomical

Digitized by Google

work, perhaps, accounts for the imperfect recognition by so many of us of how much John Hunter also occupied himself in *Botanical* research. In one of several physiological papers, after discussing the agreements and the differences between that which he terms "common or original matter and animate matter,"—or, as we should now express it, between inorganic and organic substances—and affirming the derivation of the latter from the former for the reason that "animate is found to return to inanimate "matter," he proceeds to analyse the resemblances and the differences of the matter of which animals and vegetables are composed. He restricts to vegetables the "power of immediately converting common [*i. e.* inorganic] matter into their own kind;" and from this he draws the inference that "a vegetable seems an intermediate link between common and animal matter."

In his lectures on the Principles of Surgery, he reviews the "accord [existing] between the physiological endowments of vegetables and those of animals." He mentions that "a *self-moving* power has been observed and is universally allowed in vegetables"; and he adds that "this principle seems to be as much a property in vegetables as in animals." He illustrates internal mechanical work done within the vegetable tissues by reference to Hales's notable experiments on the rising of the sap in trees; and he contrasts the magnitude of the force employed in this movement with that exerted in the heart's

Digitized by Google

systole. Having defined *irritability* as the power of responding to stimuli by internal and external work, he calls attention to the visible movements of "whole parts of plants," as examples of this property. He adduces the movements of the leaves of the leguminous plant, the *Hedysarum gyrans*, as an instance of this phenomenon; and he comments on an apparent analogy between these movements and those of respiration in animals suggested by their periodic repetition in both divisions of organic nature. Here he is, however, careful to avoid the error of attributing to these superficial resemblances an essential correspondence of function. With characteristic cautiousness he proceeds:—"This [*i. e.* the recurring leaf-movement] is an action apparently similar to breathing in animals, though, perhaps, it does not answer the same purpose."

The circling movements of *tendrils*, as if seeking for a mechanical support, and their twining round this when they have come into contact with it, did not escape his notice. Neither did he overlook the remarkable circumstance which characterizes the twining of the stems of certain climbing plants, viz. its constant direction for each plant. He cites the Honeysuckle (*Lonicera*) and the Hop (*Humulus*) as climbers, of both of which he says "their stems turn to the left; whereas the stem of *Clitoria* (a pea) and that of *Convolvulus* turn to the right."

He instances *Dionæa Muscipula* (Venus's Fly-trap) and the *Mimosa pudica* (Sensitive Plant) as plants

Digitized by Google

endowed with considerable powers of movement. He remarks that "the leaf of *Dionæa* upon being touched closes up, and as it were confines the stimulating cause"; that it shuts and entraps the insect which, in alighting upon its upper surface, has touched the little cluster of extremely irritable hairs, those projecting above the general level of the cuticle.

Of the *Mimosa pudica* he remarks that it bends its leaflets in response to a coarse mechanical stimulus and also to the subtle excitation of varying quantities of light incident upon them. In connection with excitation of light he mentions the Goat's-beard (*Tragopogon*) and *Calendula pluvialis,* two plants in the large order *Compositæ,* and he says that they and many other plants close their blossoms towards night or at the approach of rain. Of this habit our indigenous Centaureas (*Erythræa*), once of high medicinal repute, and the Scarlet Pimpernel (*Anagallis arvensis*) supply familiar examples. Then he passes on to tell us that some other plants, as certain species of Convolvulus, open their flowers in the evening and close them at the approach of the sun. In striking contrast to these dusk-loving plants, he mentions that nearly the entire class *Diadelphia* (now *Leguminosæ*), which comprises, he adds, chiefly "wing-leaved plants," close their leaflets "towards night, not expanding them till morning," and he remarks that this phenomenon had been called by Linnæus the "sleep of plants." This reference to the great Swedish botanist is interesting, because it proves John Hunter

Digitized by Google

to have been acquainted with Petrus Bremer's remarkable treatise bearing the Latin title "Somnus Plantarum." It is included in the "Amœnitates Academicæ" of Linnæus, published at Stockholm in 1759. In this instructive memoir Bremer asserts "that plants possess most qualities in common with animals—they feed, they have movements and rest, they have excretions, and they celebrate their nuptials." To Bremer we are indebted for an anecdote of the circumstances which first brought to the great botanist's notice the phenomenon of the folding of the leaves of certain plants at night, before unrecognized. Linnæus, he tells us, had placed in charge of an assistant a Lotus (*Ornithopodioides*), and had enjoined him to take particular care of it. The Lotus blossomed. Throughout the day its conspicuous blossom attracted notice; but in the evening when the assistant visited the plant, to his consternation, the blossom was not to be seen. The unhappy man, conceiving that the blossom might have been surreptitiously plucked by an evilly-disposed person, watched the Lotus more closely than before. Next morning a blossom again appeared: in the evening it had again vanished. Perplexed and unable to account for this singular occurrence, but convinced that the blossom had not been stolen, the assistant hastened to Linnæus and told him what had happened. Linnæus at once went to the Lotus, and on closely inspecting it he detected the vanished blossom still actually there, only it was closed and hidden from view, mantled by

Digitized by Google

the green leaves wrapt about it. Attention once aroused, this phenomenon was quickly found to be common to many other plants. That it should have so long escaped recognition, and then owe its discovery to an accident, is but one of many instances that could be adduced to illustrate how easily do circumstances for which we are not looking pass unnoticed, even though daily occurring beneath our very eyes.

The *Mimosa pudica* was made by John Hunter the subject of a study into which he threw himself with characteristic energy. He writes:—"In order to have the greatest part of the day before me I began my experiments at eight in the morning, while the leaves were in full expansion, and I continued them till four in the afternoon, as longer would not have been just, for they begin to collapse of themselves between five and six o'clock." With his peculiar aptitude for planning an experiment, he contrived a small screen upon which he could trace and measure the arc through which a selected leaflet moved in response to a certain stimulus. In this way he found that "the leaflets are less affected as they become accustomed to the stimulus; that they require a stronger and quicker stimulus to produce motion after being some time accustomed to it"; and "that they erect themselves less after a repetition of such actions." Here the analogy of the corresponding occurrences in connection with excitation of animal tissues is very obvious. Searching for the mechanism

Digitized by Google

concerned in the movement of the *Mimosa* leaflets, John Hunter discovered that "the motion is principally confined to one part, and this differing from the others in external appearance, which difference is its increased thickness and uniformity of surface." Thus he locates the motor-mechanism in the swelling at the base of the petiole, and in the homologous parts of the stalks of the leaflets. Next he tells us that he slit longitudinally the swelling on the "foot-stalk," and also that part of the stem on which it stands, and he is about to record what he saw in these parts—but here, as Palmer notices, there occurs a blank in the manuscript, which leaves us in ignorance of what he actually discerned in them. I do not gather from the context that John Hunter employed the compound microscope in this investigation. The contrary appears more probable, for the use of the microscope was then only dawning, and vegetable histology had made relatively little advance since Malpighi began to cultivate it in the latter half of the preceding century. We at our stand-point can hardly conceive the possibility of Malpighi holding concurrently the Chair of Botany and that of Zootomy in his University—Bologna. Yet in both these chairs he made discoveries which gained for him enduring fame. We medici are wont to think of Malpighi as an anatomist only, whose honoured name has come down to us chiefly in association with certain minute bodies in the kidneys and spleen, and with a certain stratum in the skin; but botanists revere Malpighi

Digitized by Google

as the founder of vegetable histology. For John Hunter it may fairly be claimed that he pushed his investigation into the motor-mechanism of the *Mimosa* leaflets as far as was then practicable with the means at his command. Later investigators have demonstrated that when in a young, vigorous, succulent *Mimosa* plant a cut is made with a sharp knife into the petiolar swelling dividing its parenchyma down to the central strand of vascular tissue, a drop of water oozes from the wound, upon which follows the well-known movement of the leaf. In the absence of this effusion of water no movement of the leaf occurs. Professor Julius Sachs, who in late years has done so much to advance the study of vegetable physiology, has further demonstrated that the visible leaf-movement is caused by the afflux of water in the petiolar parenchyma, distending this tissue and thus causing it to become elongated more than the less extensile axile band of vessels. By such distension of the mass of parenchyma situated above the axile vascular bundle, the upper part of the petiolar swelling is lengthened disproportionately to the lower part, and the leaf of necessity bends down; whereas when the lower mass of the parenchyma is turgid the opposite occurs, and the leaf erects itself. By the device of removing first the upper and then the lower mass of parenchyma, Sachs was able to demonstrate that only the latter mass—that lying below the axile vessels—is endowed with this irritability.

Digitized by Google

It is now known that the movements of the *Mimosa* leaflets are attended with the production of feeble electric currents. Such currents have also been demonstrated by Professor Burdon Sanderson to attend the movements of the leaf of *Dionœa Muscipula*. Dr. Kunkel, working in Sachs's laboratory, has since then demonstrated that weak electric currents accompany the movement of water in the vegetable tissues, however this movement is originated, and thus the generation of such electric currents proves not to be peculiar to leaf-movement excited by external stimulation.

Whilst experimenting on the *Mimosa*, John Hunter observed that when he touched the leaflets the visible effects of the local stimulation spread to the neighbouring leaflets, which he saw bend down in pairs until all the leaflets of the compound leaf were folded. He noticed, also, that this progressive effect of the stimulus spread from the point where it was applied more readily in the direction towards the stem of the plant than in the opposite direction towards the peripheral end of the leaf. Sachs, and with him some others, appear disposed to regard the petiolar axile vascular bundle as the path along which the molecular disturbance initiated by the application of the stimulus travels; but, whether this or the parenchymatous tissue is the path, it seems probable that a molecular disturbance in the living, active cell-protoplasm is the efficient cause of the afflux of water that produces the leaf-movement.

Digitized by Google

The protoplasm of adjoining vegetable cells is now known to be continuous through minute openings in the cell-walls, so that we are warranted in regarding the protoplasm in living vegetable tissues as a continuum; and thus the propagation of a molecular disturbance to considerable distances beyond the point of application of a mechanical stimulus originating it becomes easily intelligible.

John Hunter's experiments on the *Mimosa* were not limited to the effects of mechanical stimulation. He also experimented on this plant with heat, with chemical solutions, and with ether. He tried also the effect of a tight ligature placed around the stem or branch, and he found that when the part below the ligature was cut, very slight or no movement of the leaf occurred.

Continuing his discussion of the resemblances between animals and vegetables, he remarks "that vegetables are supposed with great reason to have an action analogous to breathing, for the same kind of air which kills animals which do breathe, certainly kills vegetables also." John Hunter touches this subject so briefly that he leaves us in uncertainty whether he had himself experimentally investigated the influence of gases on plant-life, or had merely adopted the conclusions of others This latter appears to me more probable, when we bear in mind the stand-point of the chemistry of the gases in his day. Carbonic acid gas was discovered by Black in 1667; nitrogen by Priestley in 1772; oxygen also by

Digitized by Google

Priestley in 1774; and hydrogen by Cavendish in 1776, the year of John Hunter's Croonian Lecture, from which I have just quoted.

We know (as Palmer has noticed) that John Hunter and Cavendish were personally acquainted, for Hunter himself tells us that Cavendish examined for him "air" contained in certain bladders present on the intestines of a hog sent to him by Jenner. There is, then, no improbability in the supposition that John Hunter may have derived from Cavendish his knowledge of the influence of gases on vegetable life. However this may have been, botanists have long recognized as a general principle the necessity of the presence of oxygen for vegetable life; further, that vegetables take in free oxygen from the surrounding atmosphere; and also that they are able to seize upon oxygen when it is presented to them in weak chemical combination. Of this latter action the reduction of oxyhæmoglobin to hæmoglobin in the circulating blood by the bacillus of anthrax in animals dying of cattle-plague has been thought a significant example.

In the absence of oxygen, plants are asphyxiated; vegetable protoplasm loses its irritability, though less quickly than does animal protoplasm, because the processes of vegetable life are less actively carried on than are those of animal life.

When a plant is deprived of oxygen—as when it is placed in an atmosphere from which this gas is absent—during a short period the want of the

Digitized by Google

external supply of oxygen is in some measure compensated by the atmospheric oxygen previously enclosed in the air-spaces of the vegetable tissues; perhaps, also, some oxygen is derived by the plant from the decomposition of weak chemical combinations of oxygen normally present in certain chemical substances contained in the tissues; but these limited sources of oxygen are soon exhausted.

To this general law of the necessity of oxygen for the maintenance of vegetable life certain low forms appear to offer notable exceptions. Thus the Yeast-plant (*Saccharomyces cerevisiæ*) can live and even increase in an atmosphere devoid of oxygen. Its highest life-phase, however, requires the presence of oxygen, for the plant does not produce spores unless it has access to the atmosphere. Then, also, there are certain *Schizomycetes* to which free oxygen seems to be positively hurtful—they die in its presence. The explanation of this singular phenomenon is still wanted.

The final products of the oxygen taken into the tissues of the plant are carbon-dioxide and water. Of these the former is exhaled from every part of the plant's external surface. This, Van Tieghem says, is the most constant phenomenon of plant-life; and thus in the matter of gas-exchanges we find confirmed the impression mentioned by John Hunter as current in his day, viz. that a very close correspondence exists between vegetable and animal respiration.

Digitized by Google

That plants, like animals, have "a power within themselves of producing or generating heat" did not escape John Hunter's notice. He also investigated their power of resisting very low temperatures, employing in some experiments freezing mixtures; noting the effects of these on succulent as well as on woody plants, he found that the latter better resisted great cold.

He also carried out a series of observations, prolonged over a year, on the internal temperature of trees relatively to that of the external atmosphere. He mentions that he read his thermometers at six o'clock in the morning and again at the same time in the evening; and he says that he was obliged to discontinue the observations because the sap froze in the holes bored in the tree-trunks for the reception of his thermometers. He records that he was careful to allow a sufficient interval to elapse between boring the holes and inserting the thermometers in them in order that the heat generated by the friction of the "gimlet" might be dissipated; and he tells us also that he enclosed in a box the part of the thermometer projecting externally beyond the hole, and packed it in cotton-wool, in order to protect it "against all immediate external influences either of heat or cold."

John Hunter also made a series of thermal experiments on vegetable seeds similar to others he had made on eggs, and he mentions his intention to record these. No trace of such record has come down to us; if actually made, it may, perhaps,

Digitized by Google

have been amongst the MSS. burned by Sir Everard Home.

John Hunter has left us a brief account of experiments made by him in connection with the movement of the sap. We possess, also, short statements of his views concerning the influence of light on the production of the "green colour" of vegetables; on the changes undergone by the leaf in dying; on the natural decay of the vegetable tissues; on the morphology of the bud; and on "germination and generation in vegetables."

I cannot now enlarge on his work in relation to these several subjects, nor is it necessary that I should do so, since the evidence advanced is more than sufficient to justify me in claiming for our Great Master that he was a very close observer and an acute reasoner upon many of the phenomena comprised under vegetable physiology.

Leaving Botany, John Hunter's title to a place in the foremost rank of original investigators in Zoology, the other primary division of Biology, is so universally acknowledged that more than a passing reference to his researches in the Animal Kingdom may seem unnecessary, particularly within these walls; yet on this occasion I may not dismiss them with a bare allusion. His memoirs on "The General Principles of the Blood"; on "The Vascular System"; on "Digestion, Absorption, and Nutrition"; and on "The Growth of Bones"—even at the stand-point we have reached — require attentive study: they

Digitized by Google

show how far he was in advance of his contemporaries.

John Hunter's devotion to Physiology, which had its root in his conviction of the necessity of this "discipline" for the intelligent practice of surgery, was made a reproach by his empirical surgical contemporaries, who called him a theorist and not a practical surgeon; indeed, the tardy recognition of him as the leading surgeon in this metropolis was probably in no small degree due to this misconception of him. This comment has been made by others.

John Hunter's memoir on "The General Principles of the Blood" is certainly one of the most important written by him. From it we learn how much patient investigation, how much concentrated thought he bestowed on the striking phenomenon of its coagulation. This (he remarks) is not a property of the blood as a whole, but only of one of its component parts — the "coagulable lymph." Then with nice determination he adds, "This would better be termed coagulating lymph," since "blood-serum also contains a coagulable substance which, however, needs the addition of a chemical agent for its change from a liquid to a solid state."

John Hunter considered "coagulable lymph" (fibrine as we term it) to be the most important constituent of the blood, chiefly because he found it universally present in the blood. He sought to ascertain the influence of temperature on the coagu-

Digitized by Google

lation of fibrine, and he established that this latter is retarded by cold and hastened by heat.

The effect of rest and of motion on the coagulation of the blood also occupied his attention, with the result that he was led to regard rest as an important direct factor, but not the immediate cause.

The final outcome of all his experiments and observations on the blood was the view respecting its coagulation which I state in his own words:—"That the fluid state of the blood is connected with the living vessels which are its natural situation, and with motion; and that where there is full power of life the vessels are capable of keeping the blood in a fluid state." Do not these views harmonize closely with those now held on this subject?

The white corpuscles of the blood appear to have been unknown to John Hunter, which will not surprise us if we bear in mind the imperfection of the compound microscope of his day, and also the entire absence of our numerous aids, of which I need only instance the use of differential staining agents, by which so many delicate details of minute structure have been disclosed.

How narrowly John Hunter scrutinized every unusual circumstance that came before him is shown by his remarks on *Liphæmia*. He writes:—"The serum of the blood is often wheyish, and then upon settling it often throws up a white scum like cream." "This was most probably first observed in human blood, but it is not peculiar to it." He had noticed

Digitized by Google

it more frequently in the blood of breeding women, but he had seen it in others, and sometimes in men. Examined with the microscope he found this scum to be composed of globular particles which were not soluble in water, and which rose to the top when placed in water. This pathological condition has in recent years attracted much attention *.

Many and varied experiments were made by John Hunter to determine the cause of the different colour of venous and of arterial blood. He noticed the influence of respiration on the colour, and to the objection advanced by some, that in the lungs the blood cannot come into contact with the air, he opposed the familiar fact that the bright red tint assumed by the outer surface of a blood-clot when exposed to the atmosphere "extends some depth into the clot, whence it is evident that air can and does penetrate animal matter."

Passing to the "Vascular System," we find that John Hunter notices the predominance of muscular over elastic tissue in the coats of the smaller blood-vessels; and he then comments on their respective influences on the calibre of the vessels. He also notices the branching and anastomosis of arteries, and he discusses the effects of these arrangements on the velocity of the blood-current. Then he investigates the pumping force of the heart in relation to the resistances offered by the arterioles; the relative capacities of the venous and arterial systems; the

* Trans. Pathol. Soc. Lond. xxxviii. 1883.

Digitized by Google

retardation of the blood-current in the veins; and the form, structure, and distribution of the valves in the last-named vessels.

John Hunter's observations on "Digestion and Nutrition," though much less extensive, are scarcely less instructive than those I have just noticed. I shall cite one only, that on the digestion of the stomach by its own juices after death, occasioning appearances that had previously been regarded as pathological, and respecting the real nature of which much acute difference of opinion continued long after to exist, notwithstanding his thorough exposition of the circumstance.

In a communication made by him to the Royal Society at the instigation of its President, Sir John Pringle (read June 18th, 1772), he insists on the prime importance of a correct knowledge of the appearances produced in the tissues of the body by those changes which they naturally undergo in persons dying suddenly, as from fatal violence inflicted on them when in perfect health. He significantly remarks that, in absence of this knowledge, appearances, collectively products of putrefaction, may easily be mistaken for others the results of disease, pathological in their nature, and occurring during life; and thus confusion and misapprehension will arise.

He proceeds to state that "there is a case of mixed nature which cannot be reckoned a process of the living body, nor of the dead; it participates of

Digitized by Google

both, inasmuch as its cause arises from the living, yet it cannot take effect till after death." He adduces the suggestive fact that "animals or parts of animals possessed of the living principle, when taken into the stomach, are not affected by the [digestive] powers of that viscus so long as the living principle remains." "Thence it is" (he adds) "that we find animals of various kinds living in the stomach or hatched or bred there; but the moment that any of these lose the living principle they become subject to the digestive powers of the stomach."

His argument is that "if the living principle was not capable of preserving animal substances from undergoing that process [digestion] the stomach itself would be digested [during life], which it is not."

The "appearance" which he ascribed to post-mortem digestion is "a dissolution of the stomach at its great extremity, in consequence of which there is frequently a considerable aperture made in that viscus. The edges of this opening appear to be half dissolved, very much like that kind of dissolution which fleshy parts undergo when half digested in a living stomach, or when dissolved by a caustic alkali, namely, pulpy, tender, and ragged."

At a loss to explain these appearances, John Hunter had supposed them to have been produced during life, and to have been the cause of death; but the absence of any associated symptoms, and their frequency in persons who, in good health, had

Digitized by Google

died violent deaths, occasioned him much perplexity, and had made him, as he says, "suspect that the cause was not even imagined." He tells us that the first time he observed these appearances was under circumstances that precluded their causation by disease. "The man had just before his death made a hearty supper of cold meat, cheese, bread, and ale. On opening his body a large hole was found in the stomach, through which part of the ingesta had escaped into the general cavity of the belly." Doubtful as to what this might mean, John Hunter says that he made "many experiments on digestion, in different animals, all of which were killed at different times after being fed with different kinds of food; some were not opened immediately after death, and in some of these I found the appearances thus described in the stomach."

This memoir is worthy of study if only as an illustration of John Hunter's method of work: whenever puzzled by anything of which the explanation did not immediately present itself, he turned to experimentation for the solution of the difficulty.

These very incomplete references to some of his more important physiological researches prove that as an original investigator in this branch of Biology John Hunter was in line with the foremost workers of his day.

How great an anatomist he was is evidenced by his published papers; by the great value in which his lectures delivered in the Windmill Street Rooms

Digitized by Google

were held by those who made the effort to understand them; and it is told yet more eloquently by his preparations on the shelves of our Museum. In Anatomy, as I have already said, John Hunter was not a mere accumulator of facts, nor a mere describer of figure, colour, and the relative position of the organs and members of the animal body, but he sought for the explanation of these. He tried to import into the Art of Anatomy the character of a Science. He was ever seeking the how, the why, and the wherefore of the facts disclosed by his scalpel; ever reasoning inductively from particular instances, and ever trying to deduce general laws.

But John Hunter was not only a distinguished Zootomist, Anthropotomist, and Physiologist; he also prosecuted assiduously researches in Embryology, previously little studied, and he reaped in it a rich harvest. How keenly, how penetratingly he observed, and how sagaciously he interpreted what he saw, is apparent in his article on "The Development of the Chick." In order to secure a supply of eggs for this research he kept large numbers of fowls and also a flock of geese during several years.

His labours were not limited to *Ontogeny*, the development of the individual; but he pressed onwards to the study of *Phylogeny*, the evolution of the "Stem."

He writes:—"We may observe that in natural things nothing stands alone; that everything in nature has a relation to or connection with some

Digitized by Google

other natural production or productions; and that each is composed of parts common to most others, but differently arranged. Therefore in every natural production there is an appearance of an affinity in some of the parts of its composition [with those of some other natural production]; and where there are the greatest number of these affinities [or corresponding parts], the correspondence or affinity between those of one production with those of another, the nearer are those [natural productions] allied."

In another passage, after premising with characteristic vigour of language that "definitions are the most damnable things," he defines *species* as "things that have the same relationship in their most essential properties, however they may differ in others." He continues:—"Animals breeding in the full extent of that process constitute the species, although they may differ in some of their parts or other circumstances; but which [differences] are less essential, only constituting a variety."

He comments on the greater tendency of domestic species to variation than obtains in wild animals, and he illustrates this difference by the many diverse breeds of dogs, and the few distinct races of wolves. He attributes this difference to the existence of domestic animals under other than their natural circumstances;—in short, he recognizes the plastic influence of environment. He perceives "in a great number of species a considerable variety in the same; and from this variety in the same species, it becomes

Digitized by Google

a doubt whether they were all original, or none of them, or, if any one be original, which that one is."

He refers to the variability of species in more than one passage, and he makes the significant comment that some variations are transmissible to offspring. He tells us that "it may certainly be laid down as one of the laws of Nature for species to deviate from their type under certain circumstances"; and he continues, "It is neither necessary nor does it follow that all deviations from the original must be a falling off; it appears just the contrary; therefore we may conclude that nature is improving her work, or at least has established the principle of improvement in the body as well as in the mind."

In these passages, laboured and somewhat deficient in perfect clearness of expression, we find John Hunter enunciating the principles of the inherent variability of species; of the modifying influences of environment; of the transmissibility of variations from parent to offspring; and of evolution from lower to higher life forms; in short, in those of his memoirs which we possess there is to be found abundant evidence that his mind was often and deeply engaged in the consideration of the pregnant questions comprised in the idea of *evolution*, around which so much and such fierce controversy has been waged in our own day.

The significance of past forms of life did not escape him: he studied their fossil remains, of which he collected a large number. In a memoir communi-

Digitized by Google

cated by him to the Royal Society on a series of fossil bones from caves at Gailenreuth presented to that body by His Serene Highness the Margrave of Anspach, we find John Hunter investigating the circumstances of their fossilization; comparing the forms of these bones with those of extant animals; reviewing the geographical distribution of animals in past time; and speculating, from the gisements of fossils, upon the form, etc., of the earth's surface in past ages.

From these and similar considerations John Hunter inferred a duration of our earth prolonged through "many thousand centuries." This chronology was so greatly at variance with that then universally accepted, that a statement of it in a second memoir sent in by him to the Royal Society caused so great misgiving in its Council, as led to a suggestion being conveyed to him through a friend that he should substitute years for centuries. With characteristic adherence to his convictions, John Hunter would not modify his original statement, and he withdrew the paper. Owen mentions this on the authority of William Clift.

John Hunter's researches were not limited by the walls of the dissecting-room, museum, and study; outside these he was a close observer of wild living nature. He was fully alive to the great value of both these lines of work. In some fragmentary notes on Natural History, edited by Owen *, John

* 'Essays and Observations by John Hunter,' edited by Richard Owen, vol. i. p. 24.

Digitized by Google

Hunter remarks that "writers on the natural history of animals have been of two kinds, one [concerned in] only what they could observe externally, such as form and mode of life; the second [studying only] the internal parts and the structure of the whole animal, which was performed by the anatomist. As the [subject of the] first has an immediate connexion with [that of] the second, the describers of form conjectured what the structure ought to be by consulting the works of the anatomist; and the anatomist conjectured what the living history is or ought to be from the Natural History of the others; filling up what he conceived to be just, and fancy supplying the rest. But such union of knowledge does not properly match. It is one building built at different times, an addition to an original plan. It is no wonder, therefore, that the whole is imperfect." Can we pronounce all later anatomists and writers on Natural History free from this reproach?

His remarkable memoir on the life-history of the Honey-bee testifies to John Hunter's excellence as a naturalist. For the convenience of closely observing his bees without disturbing them, he had hives constructed with glass windows, which allowed him at all times to watch their occupants. He enquires into the causes of the deaths of certain bees in winter. He mentions that "there was plenty of honey in their hive; that on closely inspecting the dead bees he found they all died with their proboscis extended, their stomachs were full of

Digitized by Google

honey, and their intestines, especially the lower part, also full of excrement." No circumstance, however minute, eluded his notice! Next we find him making observations on the heat of bees. "Without warmth," he observes, "they became dull, inactive, and torpid." He tells us:—"On July 18th at 10 o'clock P.M., wind northerly, thermometer at 54° in the open air, I introduced it into the top of a hive full of bees, and in less than five minutes it rose to 82°, and at one o'clock to 84°, and at nine in the evening it was down to 78°. December 30th, air at 35°, bees at 73°."

John Hunter made the discovery that "the wax is not gathered by the bees from the flowers as is farina" (pollen), "but it is produced by the bees themselves." "It may," he writes, "be called an external secretion of oil. It is formed between each scale on the under side of the belly." He detaches the minute flake, warms it on the point of a needle at the flame of a candle, sees it melt and run into a drop, and then burn in the manner of wax; in short, it is wax.

He describes the building of the comb, and of the royal cell; the deposition of eggs by the queen, their attachment to the bottom of the cell, and their occasional transference to other cells from those in which they were first placed; the storing of bee-bread for feeding the grubs; the development of the grub, its pupal phase, and its final escape from the cell as the imago. He notes the different life-forms

Digitized by Google

present in the community, the queen, the males, and the working-bee, which, as he quaintly expresses it, "cannot be called either sex." Finally he describes the anatomy of the Honey-bee, and he comments on its special senses. With equal thoroughness he investigated the life-history and habits of the Wasp and the Hornet.

We also find him occupied in a study of the economy and anatomy of the Humble-bee (*Bombus terrestris*), on which subjects he has left quite a long note. With unflagging industry he examined all the inmates of a nest of this bee, and found them to comprise 157 females and 25 males. He noted that the former have longer proboscides than the latter. He observed that the Humble-bee does not colonize as does the Honey-bee; it does not swarm; a queen does not leave the hive attended by a large train of followers and found a new colony, but "the family is begun by a single female, later assisted by her offspring." None but young females live through the winter. On its approach they leave the hive or nest, and seek winter-quarters in holes, which are often in dry banks, whence they emerge in spring. Humble-bees make their nests generally underground. These he describes in some detail. Then he gives an account of the deposition of her eggs by the female; of the grubs which escape from these; and of the imago. The Black Humble-bee and the Leaf-celled-bee (*Anthophora retusa* and *Megachile centuncularis*) were also objects of his study. He notices the habit of the

Digitized by Google

latter in cutting out pieces of the leaves of roses, strawberries, and bogwood, and he admires the dexterity they evince in carrying these into their holes, and the skill and neatness shown in adapting them to construct their cells.

His attention was not restricted to *Hymenoptera*, for every animate thing frequenting his garden, or that he met with in the country, seemed equally to attract him. So he has left us notes of his observation of three common beetles. Of the Dung-beetle (*Geotrupes stercorarius*) he records that in June he found the grubs nearly ready to assume the pupal phase, and that the perfect beetle escaped from the chrysalis at the end of July or in the beginning of August. The grubs he found were in nests at the bottom of holes sunk 12 to 18 inches below the surface of the ground, and these were usually near cow-dung.

He also treats at some length of the economy, life-history, and anatomy of the Common Cockchafer (*Melolontha vulgaris*), and with less detail he notices the Rose-beetle (*Cetonia aurata*).

Two common *Orthoptera* seem to have particularly interested him, and so we find him commenting on the form and anatomy of the Grasshopper (*Acrida viridissima*), noting what he discerned of the structure of its eye and speculating on its vision. He detects the predatory habit of the Dragon-fly (*Æschna grandis*) and makes the following highly characteristic note of his discovery:—"Aug. 18th, 1778, at eight in the evening I saw the Dragon-fly flying

Digitized by Google

about, making short turns which were performed very quick. I also observed gnats flying; and what took my attention most was his making up to a gnat, and the gnat was seen no more. Therefore I conjectured he was feeding on them. I caught him and opened him next morning, and could observe in the stomach the scales of some insects."

What a picture this little anecdote gives us of the acuteness of John Hunter as a field-naturalist!

As a zootomist and morphologist John Hunter could not be satisfied with the highly artificial zoological classification of his time, He marks that the want of an adequate knowledge of these preliminary and indispensable studies had led even the great classifier Linnæus into some very singular arrangements in the earlier editions of his 'Systema Naturæ,' of which John Hunter mentions one, viz., the placing together, in one order of Mammalia, man, the elephant, and the bat, because in each the mammæ are pectorally situated. Such classifying as this, he caustically observes, may be pertinent in respect of nipples, but not as regards animals.

He did not stop at showing the defects of the then current artificial systems of classification of animals, but he suggested as bases for a natural classification the arrangement of the vascular, the respiratory, and the nervous system, and he tentatively drew out the scheme of a natural classification founded on a combination of what he termed essential and circumstantial characters. Of the order Mammalia he gives

Digitized by Google

as essential characters "a four-chambered heart, lungs confined to a proper cavity, the enlargement of which is the cause of respiration; lungs divided into small cells; respiration quick; viviparous," etc.; whilst circumstantial characters are found in the construction of the auditory organ.

This illustration will suffice to prove how sound and how advanced were John Hunter's views as a Systematic Zoologist.

If in this sketch, imperfect, incomplete, as I know it to be, I have in some small degree succeeded in presenting to you our Great Master, as one of the most indefatigable workers, one of the most earnest seekers after truth, one of the very closest of skilled observers, one of the most sagacious expositors of the facts of vegetable and animal life, I shall not, I hope, have altogether failed in the design I aspired to place before you on this commemorative day—a presentment of John Hunter as a *Biologist*, in the truest and widest sense of this now much used word.

TAYLOR AND FRANCIS, RED LION COURT, FLEET STREET, E.C.

Digitized by Google

Digitized by Google

Digitized by Google

COUNTWAY LIBRARY
HC 2836 F

t. 1806
The Hunterian oration: Royal Co1895
Countway Library BFL0402
3 2044 046 284 931

Digitized by Google

t. 1806
The Hunterian oration: Royal Co1895
Countway Library BFL0402
3 2044 046 284 931

Digitized by Google